Business & Enterprise Systems

Integrity - Service - Excellence

Requirements Development & Management

Current: 12 October 2016

Objectives

- **Provide introductory level overview of the Requirements Management and Development Processes**
  - **Introduce the BES Process Directory (BPD), documents associated with requirements**
  - **Introduce some requirements engineering techniques and methodologies**

Overview

- Introduction to Requirements
- Requirements Development Processes
- Requirements Management Processes
- Requirements Specifications in the BPD
- Other Requirements-Related Documentation in the BPD
- Requirements Traceability
- Summary, Review, and Feedback

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What About You?

- **Please tell the class about yourself…**
  - **Name**
  - **Work Information**
    - **Program or Project?**
    - **What is your role?**

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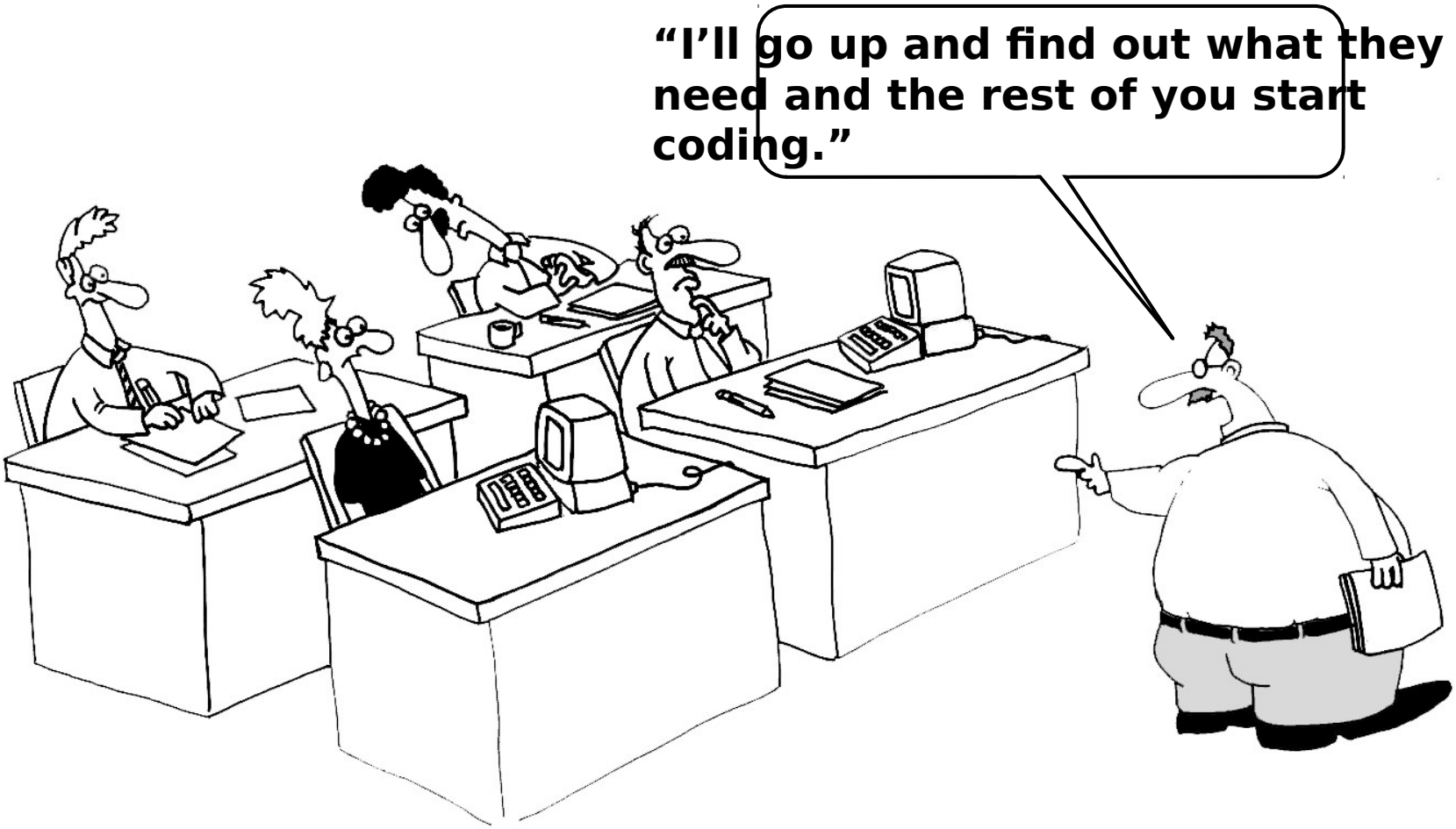
The Typical Direction



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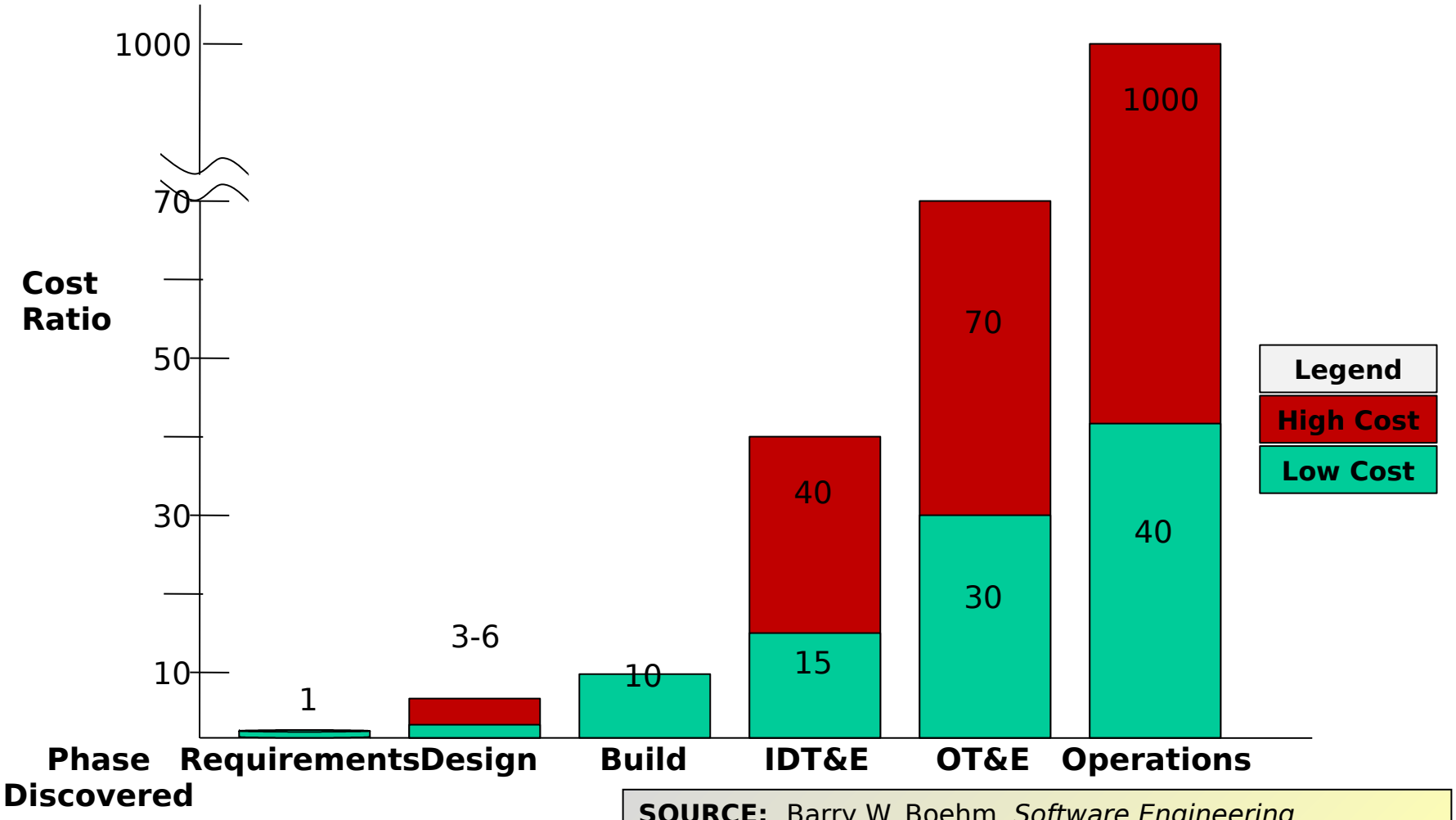
Requirements Lessons Learned

- **Accurately defining requirements is the most important part of any project**
- **Requirements definition is a discovery, invention, and derivation process, not just a collection process**
- **If teams don't get requirements right, it doesn't matter how well they execute the rest of the project**
- **Customer involvement is the most critical contributor to requirements quality**
- **Change happens; managing change is critical**
- **Teams never create perfect requirements**
- **Communication is essential!**

Deficiencies in development, documentation, and management of requirements is the major cause of software program failure!

The Cost of Poor Requirements



SOURCE: Barry W. Boehm, *Software Engineering Economics*
Englewood Cliffs, NJ, Prentiss Hall, 1981

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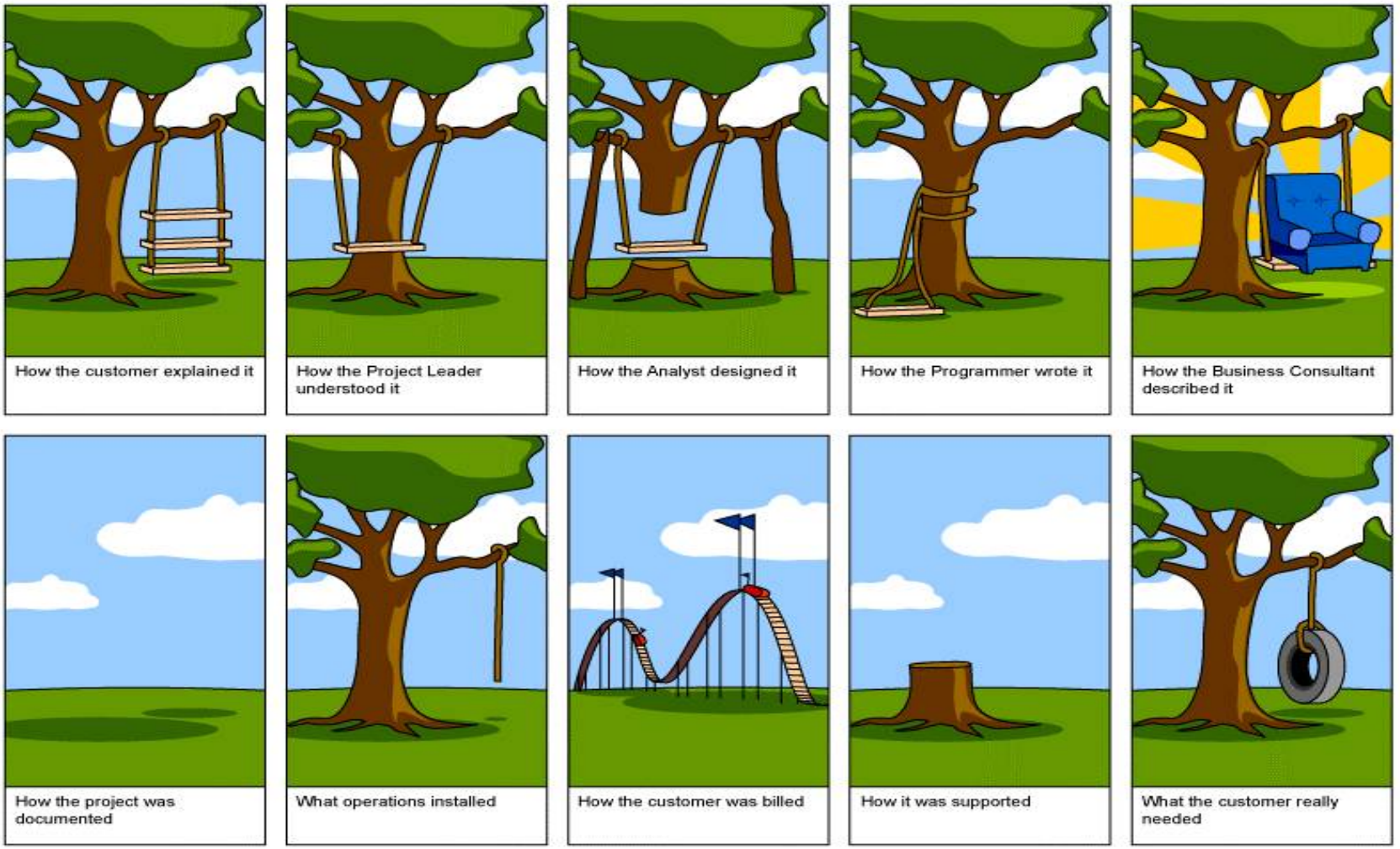
A Classic Example…


How the customer explained it
How the Project Leader understood it
How the Analyst designed it
How the Programmer wrote it
How the Business Consultant described it
How the project was documented
What operations installed
How the customer was billed
How it was supported
What the customer really needed

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Definition: "Requirement"

A requirement is a *validated need* justifying the timely allocation of resources to achieve a capability that will accomplish approved objectives, missions, or tasks.

- **"Shall" Statements of Customer Needs?**
- **Key Performance Parameters?**
- **Deficiency Reports?**
- **Technical Upgrades?**
- **Regulatory and Statutory Requirements?**
- **…others?**

Who identifies your requirements?

Functional Review Board (FRB)

- **The Functional Review Board (FRB) – chartered board made up of customers, user representatives, and the PMO**
  - **Primary responsibilities: identification, review, clarification, and prioritization of functional requirements for a system**
    - **This board is usually the source of requirements for a system**
    - **May be documented in a number of different ways (e.g., Excel Files, Change Requests, Word Documents, Deficiency Reports, C&I Requirements Document, etc.)**
  - **Alternate responsibilities:**
    - **Recommend the content (e.g., requirements) and sequence of releases to the Configuration Control Board (CCB)**
    - **May be the body that determines acceptance criteria for a release**
    - **Members often help PMOs by providing SMEs for**

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Requirements Process Goals

- **Requirements Development**
  - **Requirements completely and comprehensively *elaborated and documented* to reflect needs of stakeholders**
- **Requirements Management**
  - **Requirements are *controlled* to establish baselines and estimates for product deliveries; effective change management**

Requirements Development Process

Definition: A deliberate and structured approach to understand what you intend to build *before* you design the system

- **Intended to identify, define, document, and analyze customer, product, and product component requirements**
  - **Functional Requirements**
  - **Non-Functional Requirements (Technical)**
- **Each requirement shall be elaborated to the point where:**
  - **The functional user recognizes the requirements as satisfying a specific, declared need**
  - **The designer /developer understands how to build and integrate the requirement into the system**
  - **The tester knows how it can be verified and validated (tested)**
- **BPD procedures associated with Requirements Development:**
  - **RDPR002 – Develop Customer Requirements**
  - **RDPR003 – Develop Product Requirements**
  - **RDPR004 – Analyze and Validate Requirements**
  - **RDPR017 – Develop Contractual Requirements**

Develop Customer Requirements Procedure

OPR: Functional/Requirements Analysts and Subject Matter Experts

- **Consists of identifying and elaborating stakeholder needs, expectations, constraints, interfaces, operational concepts and product concepts**
  - **Use the Procedure at any time during lifecycle when a new requirement is identified**
- **DEFINE your internal processes for documenting and managing requirements; implement a change management process**
  - **Automation should be a key focus area**
- **Communicate frequently with your Customer**

BPD Procedure: RDPR002 – Develop Customer Requirements Procedu

KNOW YOUR BUSINESS PROCESS & RULES!

Develop Customer Requirements Procedure Steps

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1. Identify requirements team
2. Update stakeholder information
3. Define scope of work (how work fits in overall environment)
4. Create or update a glossary of terms for requirements
5. Elicit customer requirements (choose one or more techniques)
6. Document customer requirements; organize customer requirements using BPD templates
   - General Requirements Specification (GRS) ***or***
   - ConOps, System Subsystem Specification (SSS), and System Requirements Specification (SRS)
   - **Recommendation:** Automate using a requirements management tool (e.g., HP ALM
7. Verify characteristics of requirements information; evaluate customer requirements and outline acceptance criteria
8. Develop and document initial operational concepts and scenarios

Characteristics of a Good Requirement

- **Understandable – we know what's needed**
- **Correct / Precise – it will do what's needed**
- **Unambiguous – everyone interprets it in the same way**
- **Complete – it can be fully documented**
- **Consistent – it is not contradictory with other requirements**
- **Interoperable – dependencies among requirements are known**
- **Verifiable / Valid – it can be tested**
- **Singular –it only appears once**
- **Traceable – it can be traced through design, test, and delivery**
- **Prioritized – relative importance is understood**

Requirements Elicitation Techniques

- Brainstorming
- Assessment of Existing Products
- Business Process Reengineering and Business Rule Analysis
- Problem Statements & Ishikawa Diagrams (Fishbone Diagrams)
- Data Flow Analysis/Modeling
- As-Is Architectural Analysis; To-Be Architecture Development
- Operational Scenario / Thread Analysis (Walk-Thru)
- Prototyping
- Questionnaires and Interviews
- Integrated Definition Methods (IDEF) Modeling
- Use Case/Use Case Diagram Development
- …..others?

Use of Imperatives in Requirements Statements

- **Imperatives are those words and phrases that command that something be provided**
  - **"SHALL" normally dictates the provision of a functional capability**
  - **“MUST” or “MUST NOT”, “REQUIRED” normally establish performance requirements or constraints**
  - **"WILL" normally indicates that something will be provided from outside the capability being specified**
- **An explicit requirements specification will use SHALL, MUST, MUST NOT, or REQUIRED**

Limit the use of “WILL” in requirements statements!

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Use of Continuances in Requirements Statements

- Continuances are phrases that use words “such as the following:” or “similar as to that shown below”
  - They usually follow an imperative and precede the definition of lower level requirement specifications
- The extent to which Continuances are used is an indication of how well requirements have been organized and structured
  - Extensive use of continuances indicate multiple, complex requirements that may not be adequately defined
  - Limit the use of continuances in requirements statements

Limit the use of Continuances in requirements statements!

Use of Directives in Requirements Statements

- Directives are words or phrases that indicate that the document contains specific examples or other illustrative information
- Directives point to information that makes the specified requirements more understandable
- The implication is the higher the number of total directives, the more precisely the requirements are defined
  - Examples include “see the table below” or “see Figure 1 below”, etc.

Use as many DIRECTIVES in specifications as possible!

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Use of Options in Requirements Statements

- Options are those words that give the developer latitude in the implementation of the specification that contains them
- This type of statement loosens the specification, reduces the acquirer's control over the final product, and establishes a basis for possible cost and schedule risks
- Examples include “or”, “can”, “may”, “optionally”, etc.

Limit the use of options in requirements statements!

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Use of Weak Phrases in Requirements Statements

- **Weak Phrases are clauses that cause uncertainty and leave room for multiple interpretations**
  - **Use of phrases such as “adequate” and “as appropriate” indicate that what is required is either defined elsewhere or worse, the requirement is open to subjective interpretation**
  - **Phrases such as “but not limited to” and “as a minimum” provide basis for expanding requirements that have been identified or adding future requirements**
- **Weak Phrases are an indication of the extent that the requirements specification is ambiguous and incomplete**
- **Examples: “adequate”, “as applicable”, “as appropriate”, “be able to”, “be capable of”, etc.**

Strengthen weak phrases in requirements statements!

Use of Incomplete Phrases in Requirements Statements

- **Incomplete words or phrases indicate the requirements specification is not fully developed or provides a basis for expansion or addition of new requirements at a later date**
  - **TBD – necessary information has yet to be determined**
  - **TBS – a required event has yet to be scheduled**
  - **TBE – a needed designation is yet to be established or yet to be estimated**
  - **TBC – a needed value has yet to be completed**
  - **TBR – a question of a condition or value has yet to be resolved**
  - **“Not defined” and “not determined” are phrases that explicitly declare that a specification is incomplete**
  - **“…but not limited to” and “as a minimum” are phrases that open the specifications to future modifications**

Eliminate incomplete phrases in requirements statements!

Best Practice: Use Cases

Definition: Use cases describe <u>functional requirements</u> in an easy-to-read, easy-to-track, easy-to-review text format

- **Use cases show only the functional requirements**
- **Use case specifications show how a goal succeeds or fails**
- **Use case diagrams show interactions and relationships between actors and use cases**
- **Use cases can and should be used to help generate test scripts**
- **Use cases are <u>NOT</u> design documents**
- **Use cases show what functionality is required, not how it will be implemented**

Contents: Use cases usually consist of two parts:

- **Use Case Model – includes actors, users/roles, systems, time, and diagrams**
- **Use Case Specification – plain text description of the functionality provided by the system (description, glossary, flows, extensions, pre/post conditions, business rules, etc.)**

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Best Practice: Use Cases (Cont'd)

- **Use cases capture *who* (actor), does *what* (interaction) with the system, and for what *purpose* (goal), without dealing with system internals (design)**
- **The primary goal of use cases is to capture exactly what functionality is required by the application being developed through extensive communication**
- **A complete set of use cases specifies all the different ways to use the system (base, alternate, exception flows) – they define all behavior required of the system needed to meet functional requirements**
- **Use cases should be dynamic but change must be controlled**

Develop Customer Requirements Procedure Exit Criteria

- Documented requirements team and stakeholder information
- Glossary of customer terms associated to requirements
- Documented customer requirements
- Documented operational concepts and scenarios
- Updated risks

Develop Product Requirements Procedure

OPR: Lead Engineer / Lead Developer / Software Engineer

- **Consists of deriving non-functional and technical requirements (product requirements) by analyzing customer requirements in technical detail**
  - **Hardware**
  - **Software**
  - **Architecture**
- **Includes identification of external interface requirements**
- **Create high-level prototype designs for all requirements**

KNOW YOUR PRODUCT!

BPD Procedure: R.D.1.R003 – Develop Product Requirements Procedure

Develop Product Requirements Procedure Steps #1

1. Identify/adjust requirements team and stakeholders
2. Define scope of product in use
3. Update glossary of customer terms for requirements
4. Establish product and product component requirements
   - Define in technical terms
   - Include technical details for design decisions
5. Create high-level prototype designs (organize product into components and select technical approach for each component)
6. Derive additional requirements from design decisions
   - Sometimes called design constraints
   - Selection of technical approach may bring new design generated requirements (i.e. GCSS integration framework, etc.)

Develop Product Requirements Procedure Steps #2

7. **Identify interface requirements**
8. **Update requirements using BPD templates**
   - **General Requirements Specification (GRS) *or***
   - **ConOps, System Subsystem Specification (SSS), and System Requirements Specification (SRS)**
   - **Recommendation: Automate using a requirements management tool (e.g., HP ALM)**
9. **Begin requirements traceability (tie derived requirements to parents)**

Develop Product Requirements Exit Criteria

- Updated requirements team and stakeholder information
- Updated glossary of customer terms associated to requirements
- Documented product requirements
- Initial Requirements Traceability Matrix (RTM)
- Draft Interface Requirements Agreements (IRAs)
- Updated risks

System Requirements Review (SRR)

- System Requirements Review (SRR)
  - Technical review to ensure all system requirements and performance requirements are defined and are consistent with cost (program budget), risk, and other system constraints
  - Typically conducted during the Define Need Phase (Sustainment framework) or the Technology Development Phase (5000 framework)
  - Generally, this review assesses the system requirements as captured in the system specification, and ensures that the system requirements are consistent with the preferred system solution as well as available technologies

Analyze and Validate Requirements Procedure

OPR: Requirements Team / All Relevant Stakeholders

- **Performed to determine if combined customer and product requirements will satisfy stakeholder needs and constraints**
- **Consists of the following:**
  - **Analysis of interdependencies between the customer and product requirements**
  - **Verify characteristics of both customer and product requirements; define acceptance criteria**
  - **Refinement of operational concepts and scenarios**

BPD Procedure: RDPR004 – Analyze and Validate Requirements Pr oc

KNOW HOW YOUR BUSINESS PROCESS & RULES WILL BE IMPLEMENTED / SATISFIED BY THE PRODUCT!

Analyze and Validate Requirements Procedure Steps

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1. Identify/adjust the requirements team
2. Update glossary of customer terms for requirements
3. Analyze and substantiate system requirements
4. Validate and capture requirements changes
5. Establish a definition of required functionality
6. Analyze requirements and verify characteristics
7. Update requirements using BPD templates
   - General Requirements Specification (GRS) ***or***
   - ConOps, System Subsystem Specification (SSS), and System Requirements Specification (SRS)
   - <u>Recommendation:</u> Automate using a requirements management tool (e.g., HP ALM)

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Analyze and Validate Requirements Exit Criteria

- Updated requirements team and stakeholder information
- Updated glossary of customer terms associated to requirements
- Requirements analyzed and documented
- Updated Requirements Traceability Matrix (RTM)
- Interface Requirements Agreements (IRAs)
- Updated operational concept and scenarios
- Updated risks

System Functional Review (SFR)

- System Functional Review (SFR)
  - Technical review to ensure that the system under review can proceed into preliminary design
  - Typically conducted early in the Design Phase (Sustainment framework) or the Technology Development Phase (5000 framework)
  - Ensures all system (product) requirements and functional (customer) performance requirements are defined and are consistent with cost (program budget), risk, and other system constraints
  - Generally, this review assesses the system functional requirements as captured in the system specifications, and ensures that the required system performance is fully decomposed to lower level sub-system functionality

Configuration Control Board (CCB)

- **The Configuration Control Board (CCB) – chartered board made up of customers, user representatives, and other stakeholders**
  - **Primary responsibility: manage the overall configuration a system through formal change management processes**
    - **This board is usually the source of requirements allocation to releases for a system; based on cost, schedule and performance estimates provided by the PMO – FUNCTIONAL BASELINE**
    - **Decisions made by the CCB are formally documented on the Configuration Control Directive (CCD) Form**
      - **Semi-formal signed agreement between the CCB and PMO on what to produce, when**
      - **CRITICAL document that helps control requirements creep within a release**

BPD Procedure: CMPR004 – Configuration Control Board Procedure

Develop Contractual Requirements Procedure

OPR: Requirements Team / Contracting Representative

- **Performed to prepare appropriate requirements documentation to be included in solicitation packages, Requests for Proposals, or Service Level Agreements (SLAs)**
- **Consists of the following:**
  - **Develop contractual requirements documentation**
  - **Identify contract deliverables and acceptance criteria**

KNOW WHAT YOU EXPECT YOUR DEVELOPER TO DELIVER!

Procedure

Develop Contractual Requirements Procedure Steps

1. Identify/adjust the requirements team
2. Refine all requirements for inclusion in contractual documentation
3. Define acceptance criteria for contract deliverables
4. Assemble contractual documentation and conduct reviews

Develop Contractual Requirements Exit Criteria

- **Documented contractual requirements with defined acceptance criteria for contract deliverables**

Requirements Management

Definition: a structured process that establishes and maintains agreement between the customer and the project team on the state and status of requirements for a system

- **Requirements Management is the sum of all activities in connection with requirements that take place *after* requirements have been developed and recorded/documented**
- **Establishes continuous oversight of system requirements**
- **Provides the mechanism to change, add, or delete system requirements, as necessary**
- **Establishes a structured requirements traceability process**
- **BPD Procedure: RDPR005 – Requirements Management Procedure**

Requirements Management Procedure

OPR: Requirements Manager, Functional Analyst, Subject Matter Expert

- **Requirements Management consists of:**
  - **Documenting, managing and archiving requirements**
  - **Obtaining stakeholder commitment to documented requirements**
  - **Having clear understanding of requirements as they evolve**
  - **Placing requirements under configuration control**
  - **Instituting effective requirements change management**
    - **Keeping track of the history of each requirement**
    - **Maintaining version control of each requirement**
    - **Maintaining traceability of each requirement**

Requirements will change…but change is not the enemy – Unmanaged and uncontrolled change is!

Requirements Specifications in the BPD

BPD OPTION #1 – Multiple Specifications

- **Concept of Operations (CONOPS) – describes how the system will be employed to meet operational needs**
  - **BPD Template: SWTM024**
- **Software Requirements Specification (SRS) – primary document for capturing customer and product requirements**
  - **BPD Template: SWTM022**
- **System/Subsystem Specification (SSS) – used in conjunction with the SRS to define customer and product requirements**
  - **BPD Template: SWTM023**

BPD OPTION #2 – Single Specification

- **General Requirements Specification (GRS) – customized specification for use by BES programs; combines content of the CONOPS, SRS and SSS under a single cover**
  - **BPD Template: SWTM012**

Other Requirements – Related BPD Documents

- **Design Document (DD) – describes how the system will be designed to meet specified requirements and operational needs**
  - **BPD Template: SWTM017**
- **Database Specification (DS) – describes how the database will be designed and integrated with the overall system design to meet specified requirements and operational needs**
  - **BPD Template: SWTM008**
- **Interface Requirements Agreement (IRA) – formal agreement between two systems that describes an external system interface**
  - **BPD Template: SWTM005**
- **Test Scripts – written to execute component verification testing (requirements) and operational scenario validation testing (system)**
  - **BPD Template: SWTM026**
  - **Best Practice: Develop test scripts in an automated test tool like HP Application Lifecycle Management (HP ALM)**

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Requirements Traceability

Requirements traceability refers to the ability to follow the life of a requirement from its origins, through its development and specification, to its subsequent deployment and use

Requirements traceability is used to capture the relationships between requirements, design, code, test, and implementation of a system

- **Traceability demonstrates:**
  - **Where requirements are satisfied by the design**
  - **Where design is satisfied by code**
  - **Where requirements are tested for functionally**
- **Traceability exposes:**
  - **Uncovered requirements**
  - **Uncovered design**
  - **Extraneous tests**

Requirements Traceability Matrix (RTM)

- **The key documents needed for Requirements Traceability are:**
  - **Requirements Documentation: CONOPS, SRS, SSS or GRS**
  - **Interface Documentation: IRAs**
  - **Design Documentation: DD and DS**
  - **System Code**
  - **Test Documentation: Scenarios and Scripts**

- **Automation can make traceability easier; several tools are available**
  - **HP Application Lifecycle Management (HP ALM) is available to BES Directorate programs**
  - **Other tools can be implemented, but at PMO expense**

BPD Guide: SWGD008 – Requirements Traceability Matrix Guide

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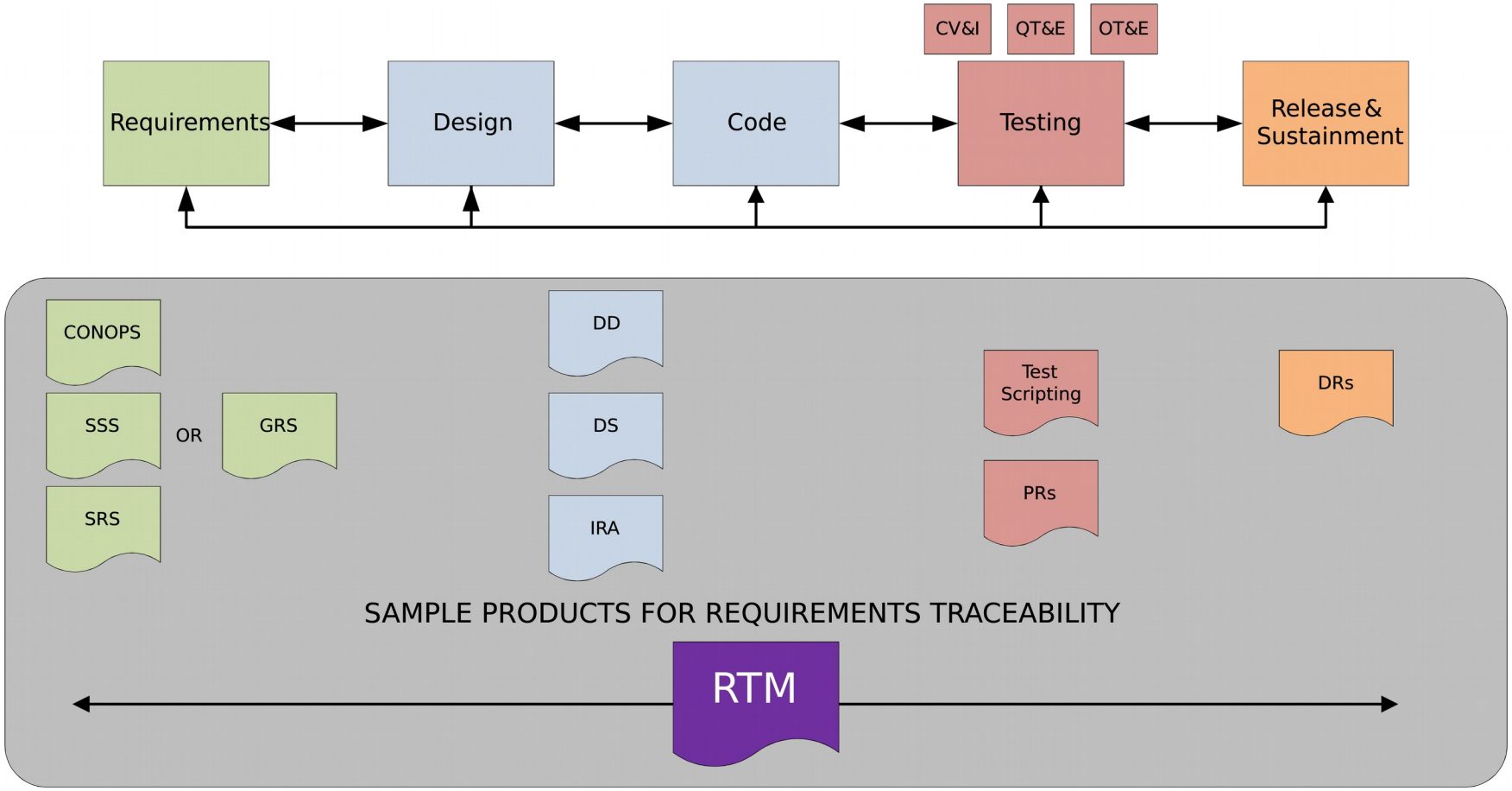
The Traceability Path



Requirements traceability is accomplished in both directions and across all activities!

What Did We Learn?

- Requirements development and management is a TEAM effort
- Requirements development, which seems simple at first, can become very complex
- Failure to properly specify requirements early can be very, very expensive! Invest the time early in the process
- The most important factor in requirements development and management is communicating to a level of understanding among all stakeholders
- Keeping “lock” on requirements is critical
  - Requirements will change – learn to manage that change
  - Use traceability to capture the relationships between requirements, design, code, test, and implementation of a system

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Recap and Feedback

- **Do you have any unanswered questions?**
- **Did we meet the objectives as stated?**
- **Don’t forget to request your CLPs!**
- **Please fill out a critique so we can improve this class for those who may attend in the future; written suggestions are very helpful**